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JOSEPH LISTER, HIS LIFE AND WORK¹

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JOSEPH LISTER was born on April 5, 1827, the son of Joseph Jackson Lister and Isabella Harris. His father was a London wine merchant of good old Quaker stock and a man of unusual ability. He devoted his leisure hours to the study of optics and was to a degree the founder of modern microscopy in that he was the discoverer of important equations which led to the production of the achromatic lens. Joseph Jackson Lister was largely self-taught and in the midst of an active business life he found opportunity to make his mathematical calculations, to grind lenses himself, and to earn a reputation which gained for him fellowship in the Royal Society in 1832. He was also a good Latin scholar, a skilful artist, and well versed in French and German.

Joseph's mother was a cultivated and beautiful woman of strong character who apparently, however, had less influence on the development of the future surgeon than had his father.

Shortly after his marriage, the elder Lister bought a commodious attractive house with fields and gardens at Upton in Essex. At that time, Upton was only a winding lane with a scattering of comfortable houses instead of a sordid part of busy London as it is now. Forest, marsh and the delightful banks of the Thames made a peaceful rural setting for the boyhood of Lord Lister. Upton was a community of the Friends and there young Lister grew up with his three brothers and two sisters among the rigorous restrictions and in the peaceful isolation of such a group.

BOYHOOD AND EDUCATION UNTIL 1852

Joseph Lister went to two private schools; the first at Hitchen and the second at Grove House, Tottenham. He was rather a precocious, serious lad, especially well versed in the classics because of his training at home with his father. The children used to read Latin classics to the elder Lister while he was dressing. On the whole, however, his amusements were those of an ordinary schoolboy. More than thirty of his early

¹ Paper read before Wisconsin Historical Seminary May 26, 1920.

school papers are still preserved. It is interesting to note that four of these dealt with the human skeleton and one on the similarity of structure between a monkey and a man. At an early age he became interested in natural history, dissecting many small animals and articulating skeletons. While still young he decided to be a surgeon and never deviated from his chosen path.

Lister's religious affiliations debarred him from entrance into the older universities, so after completing his preparatory course at the age of seventeen, he was sent to University College, London, which was distinctly non-sectarian. He spent three years there working for his A.B. in rather gloomy surroundings.

He began his early medical studies in earnest in the winter of 1848, devoting more of his time than does the average medical student to the fundamental sciences, including physics. Lister's introduction to surgery came shortly after the discovery of anesthetics, and although this discovery represents a striking landmark in the history of surgery, the change produced came only gradually. Operations were still performed at high speed and the technique used was the same as found in the pre-anesthetic days.

At University College Hospital one theatre of modest dimensions containing one small instrument cupboard, a sturdy wooden table, a single gas jet and a solitary washing basin served for every purpose including the novel one of administering the anesthetic.

In following the cases Lister observed that it seemed to be a lottery whether patients recovered or died. Inflammations, suppurations, erysipelas and hospital gangrene were the too common sequellæ of operations. In such surroundings, then, Lister obtained his first impressions of the profession which he had chosen for his life work. His cousin, Thomas Hodgkin, described him as "kind and considerate but rather dwelling apart and not making any strong friendships with his fellow students." But an older member of the group of Friends with whom they both lived spoke of him as one "who in the total excels any one I know, or have known, in bright promise for the future."

When he became a resident in the hospital, he was associated with men of other religious denominations and from other schools and thus began to have a somewhat broader outlook on life and to enjoy the pleasant club life of the hospital interne. He entered with zeal into student politics and the debating society, heading a sharp attack on the homeopaths.

He was granted the degree of M.B. of the University of London and a Fellowship of the Royal Society of Surgeons in 1852 at the completion of nine years at the University College.

During the latter part of his course, he did some original work stimulated by Wharton Jones and William Sharpey, professor of ophthalmic medicine and surgery and professor of physiology, respectively. His observations were published the next year, 1853, in the *Quarterly Journal of Microscopical Science*. The first of these papers confirmed and extended Kölliker's observations demonstrating the existence of two distinct muscles, the dilator and sphincter in the iris. The second paper also confirmed the work of Kölliker on the structure of the involuntary muscle fibers of the skin. These papers are beautifully illustrated with his own camera lucida drawings. These investigations were carried out before any of the modern methods of sectioning and staining were known, but in spite of this, the work is surprisingly well done.

Holidays were not neglected during his student days and these he spent usually with members of his family in different parts of England, Ireland and the Continent. He kept elaborate leather-bound diaries, most of which have been preserved. The style in his diaries is rather stilted and the subject matter not especially interesting. He shows, however, that he was a keen observer of geology and architecture, manners and customs, and that he had acquired considerable facility with French and German. Two sports that attracted him were swimming in the summer time and skating in the winter, although as to the latter he states that he never got beyond the making of figure eights and threes of rather small dimensions.

EDINBURGH, 1853-1860

At the end of his medical course, Lister, having no definite plan in mind, was advised by Sharpey, who had influenced him markedly during his medical course, to visit Syme in Edinburgh for a month and then to make a more prolonged trip to the various continental schools. So in September, 1853, Lister went to Edinburgh, presented his introduction to Mr. Syme, and was received most cordially. Syme invited him to his home, gave him the opportunity of assisting with private operations, and set him to work in the hospital. Lister was surprised to find that Edinburgh was ahead of London in many ways. Syme was at this period fifty-four years of age, in the prime of his work and was, perhaps, the first of British surgeons. He was a pioneer not only in the manner of teaching

clinical surgery but in the wider field of general medical education. There seems to have been a mutual attraction between Syme and Lister and, persuaded by his admiration for Syme and the unusual opportunities offered him, Lister determined to remain in Edinburgh. A month later he was made supernumerary house surgeon and soon afterwards resident house surgeon. This gave him ample opportunity, as Syme seldom interfered with the treatment of ordinary cases and accorded Lister the exceptional privilege of using his own discretion as to which of the cases admitted at night he should himself operate upon. Lister became a frequent visitor at Milbank, where Syme devoted his leisure to his garden and his orchids. There he met famous men from all parts of the world, as Syme was one of the most prominent in this important medical center. In the autumn of 1854, Lister applied for the vacant assistant "surgency" at the Infirmary. Syme promised him his support and also free access to his wards. Accordingly he hired the lecture room and began preparing for the lectures in earnest. Only four months remained before the opening of the winter session and there were many duties and distractions. One of the greatest distractions was Syme's eldest daughter, Agnes, and by the end of July he found he could do nothing more in the preparation of his lectures until the matter was settled. Fortunately it was settled favorably. One difficulty arose, however, in that Miss Syme was not a member of the Society of Friends and Quakers were not allowed at that time to marry "Out of the Society." Accordingly Lister resigned and became a member of the Church of England. This change never seems to have caused him any mental unrest.

The marriage took place at Milbank on April 23, 1856. The young couple spent a month in the region of the English lakes and at Upton and then started on a three months' tour on the Continent. In the course of this trip Lister made the acquaintance of many surgeons, visited most of the leading medical centers of Europe, and greatly improved his facility in the use of the Italian and German languages. In Vienna he met Rokitansky and saw his remarkable pathological museum.

Lister and his wife returned to Edinburgh in October, 1856, and settled in their new home, 11 Rutledge Street. This was not very attractive as to its surroundings, but was near the business houses and well adapted for consultations. He was elected to the assistant "surgency" in October, 1856. The number of students attending his lectures this year was only eight, but he was not at all discouraged. At this time he was

hard at work on his investigations on the early stages of inflammation and some experiments upon the coagulation of the blood. He read a paper before the Royal Society of Edinburgh on December 1, 1856, "On the Minute Structure of Involuntary Muscular Fiber." This again confirmed and extended some observations of Kölliker. During the early part of 1857 his letters refer to the excitement of his first public operation at the Infirmary and to the beginning of his private practice. He was delighted with his work and in a letter to his mother his attitude is shown by the statement that "fearing as I am sometimes apt to do that a mode of life so much in accordance with my tastes as mine now is must be too pleasant to be proper for me." In a letter to his father, February 26, 1857, he describes his feelings at his first operation:

Yesterday I made my debut at the hospital in operating before the students. I did two operations in the presence of a very full theatre and several surgeons and old practitioners. I felt very nervous before beginning, but when I got fairly to work this feeling went off entirely, and I performed both operations with entire comfort. And I also explained the operations and cases to the students without embarrassment. Altogether I felt very thankful at the way I was able to acquit myself. Everybody congratulated me afterwards and the students cheered me very warmly.

In June, 1857, he read an important paper on the early stages of inflammation. He made the observations for the most part on the frog's web, although he also used the bat's wing in order to utilize a warm-blooded animal. He describes very clearly the vascular changes in early inflammation, using a great variety of irritants such as hot water, mustard, etc. He apparently never detected the migration of white blood corpuscles, which was due probably to the fact that each experiment extended over a very short period of time. Cohnheim, to whom the credit is usually given for the earliest observations on the microscopic changes in inflammation, did not publish until ten years later, 1867. As a matter of fact, credit really belongs to neither of these men, but to William Addison (1843) and Augustus Waller, who made careful observations in 1839, although he did not publish until 1846.

In the summer of 1858 he started another course of lectures dealing with surgical pathology and operative surgery. His desire to give his students the fundamental facts of physiology led him to work still further on the coagulation of the blood. In his collected papers are five dealing with this subject.

During all this period Lister worked most industriously, frequently far into the night, on his experiments. Mrs. Lister

assisted him greatly, taking his dictation and aiding him with the details of his work.

Lister's private practise was growing, largely through the influence of Syme, and he was enjoying the increased prestige of his position. He was looked upon as a young surgeon of great promise and a first rate investigator. In August, 1858, the professorship of surgery in the University of Glasgow became vacant and Lister was urged to apply for the position. It was a regius professorship, and although there was considerable difficulty and vexation due to politics, Lister's appointment was finally made on January 28, 1860. The seven years in Edinburgh were accordingly brought to an end with much regret on the part of Lister, his students, and colleagues.

GLASGOW, 1860-1869

The appointment at Glasgow offered a wider opportunity for his powers than could possibly have been the case at Edinburgh at that time. In Edinburgh he was somewhat overshadowed by the strong personality of Syme, whereas in Glasgow he was now thrown upon his own resources. For the first year he was without any hospital appointment, but had plenty of private practise and came into close association with many congenial colleagues. His induction into office involved the presentation of a Latin thesis which he sat up practically all night to write and finished on the train from Edinburgh to Glasgow. This was a common habit of his. There were always many demands upon his time, and he never allowed himself time enough to write his lectures or prepare for the extramural functions that were a part of his duties. He was not given to punctuality. The matter at hand was always of greater importance than the duty of the future.

The first lecture of the winter session at Glasgow was on the importance of surgery.

He dwelt on the value of anatomy and physiology to the surgeon and amongst other surgical matters, on the importance of making serviceable stumps which he illustrated by a case of amputation of both legs in which his patient was still able to dance the Highland Fling.

The number of students in his class finally reached 182, probably at that time the largest class in systematic surgery in Great Britain. The students became very enthusiastic, made him honorary president of their medical society, and backed him in his claim to the "surgeoncy" of the Infirmary with 161 signatures. He was finally appointed surgeon to the Royal In-

firmary on August 5, 1861. In all his teaching, whether in the form of lectures, demonstrations, or the correction of student papers, he was exceedingly conscientious. In correcting examination papers, every point in an answer to a question was given its percentage value and the papers were graded with painful precision.

In spite of daily lectures and the pressure of private practise, he published at this time an important paper on the excision of the wrist for tuberculosis, which extended his reputation very considerably.

In September, 1864, Lister's mother died. The parents had been living alone at Upton for the previous six years and after the death of his wife Joseph Jackson Lister passed the remaining five years of his life in lonely isolation. His son, Joseph, from this time on, wrote a weekly letter to his father, and it is from these letters that we gain much information in regard to the daily life, ideals, work and ambitions of Lister.

In order the better to understand his most important work, namely, Lister's discovery of the principles of antiseptic surgery, it will be necessary to suggest briefly the conditions that prevailed in hospitals. At that time there was no security that the simplest operation would not end in a fatal septicemia. In Glasgow and in fact in all the cities, wards were not infrequently closed for a time on account of the frightful mortality. In Nuremberg the hospital authorities seriously considered the pulling down of the Allgemeines Krankenhaus. Microbes were looked upon as scientific curiosities, the hospital diseases, erysipelas, pyemia, septicemia, hospital gangrene, and tetanus were often called septic, but no one realized what that meant. "Surgeons were fighting all of these diseases in the dark or submitting to them as inevitable." These were the days of "laudable pus" and the common assumption was that putrefaction and purulent infections were due to the oxygen of the air.

Surgical cleanliness as understood at that time would astonish a modern observer. In the institutions that had felt the influence of Florence Nightingale, the nurses indeed were fairly neat and esthetically clean.

But no such attempt to satisfy the proprieties was made by the surgeon and his assistants. When a dresser or a house surgeon entered upon his term of office, he hunted up an old coat in the lapel of which he probably carried a wisp of ordinary whipcord for tying arteries. This garment did duty for six months or a year and was then very properly discarded. There were no such time limits, however, for the surgeons themselves. Their operating coats lasted from year to year and event-

ually acquired an incrustation of filth of which the owners appeared unconscious or even proud. This set the tone and some who were then young can remember the scorn with which they were greeted when in their reforming zeal they broke away from ancient custom, boldly took off their coats and operated with upturned shirt sleeves.

No attempt was made to isolate septic cases; nurses and dressers passed directly from erysipelas wards to healthy patients. Lister complained that in Glasgow the closets communicated directly with the wards. The supply of water even in the operating theaters was inadequate and one of the frequent duties of the operating surgeon was the performing of postmortem examinations. As in Vienna in the time of Semmelweis, the surgeon used frequently to come from the post-mortem chamber directly to the operating room, with only such cleanliness as common decency demanded. Surgeons were not ashamed to speak of a "good old surgical stink."

The mortality statistics after amputation gives some indication as to the prevailing conditions. At the Edinburgh Infirmary the death rate was 43 per cent.; at Glasgow Infirmary 39.1 per cent. At the Pennsylvania Hospital the record was unusually good, the average mortality for a series of years being 24.3, while at the Massachusetts General Hospital, the average was 26 per cent. The mortality in the French Hospitals was even greater than that in London, amounting to about 60 per cent. Billroth at Zurich reported a mortality of 46 per cent. Sir James Simpson, the discoverer of chloroform anesthesia, stated "that the man laid on the operating table in one of our surgical hospitals is exposed to more chances of death than the English soldier on the field of Waterloo."

The cause of these conditions was unknown; doubt and uncertainty existed in the minds of all. A polluted atmosphere was the generally accepted cause, although opinions differed as to how the air became tainted. The work of Semmelweis (1861) had made no impression and it remained for Lister to rediscover and extend the observations of this martyr to science.

In handling open wounds at this time, two general lines of treatment were followed. One was to encourage the formation of a scab. After the edges of the wound had been approximated, no dressing was applied, but sometimes certain powders or caustics or a piece of lint soaked in compound tincture of benzoin. The other method was known as the open treatment. The edges of the wound were allowed to remain quite open and a piece of linen protected it somewhat from flies and dust.

Some carried the first method to the point of what is called the "occlusion method." Collodion was used, completely excluding the polluting air. The occlusion method obviously did not allow the drainage of pus, so Syme adopted what he called a dry dressing. Lister pointed out, however, that this very soon became a moist dressing due to the discharge from the wound. Water dressings and bread and linseed meal poultices were in common usage in some of the hospitals. Ligatures were of silk or whipcord drawn over beeswax. Usually one end was cut off short and the long ends of several ligatures gathered together for drainage. With the progress of the purulent inflammation which so commonly occurred, the ligatures were sloughed off and secondary hemorrhage was common.

One more point deserves attention, namely, "subcutaneous" surgery, by which was meant the performance of a minor surgical operation through a puncture so small that little air was admitted. The fact that these operations were so commonly free from putrefaction was held to be due to the fact that air was not admitted to the wound.

It was under such conditions as these that Lister taught and worked, his technique being no better than that of many others. There was this difference, however: he did not believe these conditions inevitable, and he was constantly searching by observation and experiment to find out the cause of the high mortality in all hospitals.

Sepsis was known at the time, though the cause was unknown and the word "antiseptic" occurs in medical literature as early as the middle of the eighteenth century. Many antiseptic substances had been used from the time of the early Egyptians and doubtless before that. At the time of which we are writing, alcohol was freely used on the continent and it was of course the basis of all tinctures. The good Samaritan poured in "oil and wine." Glycerine was used in England, especially in cases of hospital gangrene. Chlorine and its compound, chlorinated soda, and chlorinated lime were early recognized as powerful antiseptics. Iodine was discovered in 1811, was used for a while, and then went out of fashion. In 1815 the antiseptic properties of coal-tar products were known in France and carbolic acid was discovered by Runge in 1834. As early as 1851, Calvert, an English chemist, used carbolic acid for the preservation of cadavers. Jules Lemaire worked extensively with carbolic acid and published in 1860 and again in 1863. Carbolic acid in the treatment of wounds and sores became the fashion in France for a while. All of these anti-

septics were used, however, not with the hope of preventing the occurrence of putrefaction, but with the aim of neutralizing its effects after it had developed. The two exceptions to this rule were Semmelweis in Vienna and possibly Lemaire in Paris.

In 1865, while intensely occupied with the study of suppuration, Lister learned from the work of Louis Pasteur that putrefaction was a kind of fermentation caused by the growth of microorganisms and that these microorganisms were present in the dust of the air and responsible for wound infection.

The enormous significance of the work of Pasteur was immediately apparent to Lister, who had for so many years been struggling with this problem. Since the cause of suppuration and septicemia was now known, it was obvious that the prevention of such infections depended upon keeping the causative organisms away from the wounds. His attitude can best be understood by quoting from one of his papers published in 1867.

In the course of an extended investigation into the nature of inflammation and the healthy morbid conditions of the blood in relation to it, I arrived several years ago at the conclusion that the essential cause of suppuration in wounds is decomposition, brought about by the influence of the atmosphere upon blood or serum retained within them and in the case of contused wounds upon portions of tissue destroyed by the violence of the injury.

To prevent the occurrence of suppuration with all its attendant risks was an object manifestly desirable; but till lately apparently unattainable, since it seemed hopeless to attempt to exclude the oxygen, which was universally regarded as the agent by which putrefaction was effected. But when it had been shown by the researches of Pasteur that the septic property of the atmosphere depended not on the oxygen or any gaseous constituent, but on minute organisms suspended in it, which owed their energy to their vitality, it occurred to me that decomposition in the injured part might be avoided without excluding the air by applying as a dressing some material capable of destroying the life of the floating particles.

Upon this principle I have based a practise of which I will now attempt to give a short account.

His notion then was much more like that of aseptic surgery than is generally conceded. He likened our skin to the glass of Pasteur's flasks. In a compound fracture the bottle is broken and the air with the attendant bacteria gain access to the tissues below. To be sure he paid more attention to air as a source of infection, although he recognized that his hands and open wounds were also infected.

In considering the possible methods of eliminating the air-borne infections, he chose chemical antiseptics as his means and happened to hit upon carbolic acid first. The first product

used was a crude acid known as German creosote, which he tried on a compound fracture.

Quoting from one of his papers,

After cleansing the broken limb and squeezing out as far as possible all parts of blood, a piece of calico or lint soaked in undiluted carbolic acid and held by a pair of forceps, was introduced into the wound and passed freely in all directions in order to destroy the germs that had entered either at the time of the accident or afterwards and might be lurking in deeper parts. A piece of lint similarly soaked in the acid was then applied to the wound just large enough to overlap it in every direction by half an inch. This was covered by a slightly larger piece of thin block tin or sheet lead, the object of which was to prevent the evaporation of the antiseptic. The dressing was then fixed in position by strips of adhesive plaster and some suitable absorbent material was packed around between the limb and the splints for the purpose of soaking up any blood or discharges that might escape. The blood and carbolic acid soon formed a tenacious crust or thick paste which was not removed for several days but its antiseptic properties were renewed from time to time by painting some more of the undiluted carbolic acid on its outer surface after removing the metallic plate for the purpose.

He found that the crude acid caused necrosis and sloughing, so he next used a 5 per cent. watery solution of a purer product which he succeeded in getting and a higher concentration in linseed oil. This last was too irritating, so after repeated attempts he used a putty made with calcium carbonate and a solution of phenol in linseed oil, one part in four or one part in six. This did not irritate the skin or tissues greatly. He constantly reiterated that the ideal dressing should be mild and non-irritating and he continually advanced as his ideal the establishment of conditions in compound fractures and open wounds similar to those that obtained where the skin is unbroken. He did not obtain another suitable case for the application of his principle until the spring of 1866. This also was a compound fracture and he wrote his father on May 27:

It is now eight days since the accident and the patient has been going on exactly as if there were no external wound, that is as if the fracture were a simple one. His appetite, sleep, etc., good, and the limb daily diminishing in size while there is no appearance whatever of any matter forming. Thus a most dangerous accident seems to have been entirely deprived of its dangerous element.

He published his epoch-making observations in several sections in the *Lancet* between March and July, 1867. Only one out of eleven cases died (although one had lost his leg), an almost unheard of success, especially under the abominable conditions that prevailed in the wards of the Glasgow Royal Infirmary.

From this time he continually strove to improve his tech-

nique, trying many different antiseptics and working with intense zeal on each case that came to his wards.

Lister claimed to have discovered a new principle necessitating fundamental changes in the conception of the causation of infected wounds and therefore in the treatment of these wounds. This claim was received with incredulity on the part of some, open resistance on the part of others, and apathy on the part of most persons. Unfortunately the nature of his discovery was from the first confused with the discovery of carbolic acid, and when it was made clear that carbolic acid had been used for years many considered Lister's claims palpably false. Sir James Y. Simpson led the attack on Lister in Scotland, and an anonymous letter in the *Edinburgh Daily Review* made it appear that all Lister had done was to reproduce in Great Britain what had long been the continental practise. The controversy waged rather bitterly at times and Lister suffered keenly from mortification. Attention had been directed to the use of carbolic acid and not the fundamental underlying principle, and in spite of all Lister could do, the phrases "carbolic treatment" and the "putty method" were on every one's lips. Simpson gave all credit to Lemaire and because of his extended reputation, this point of view became widely disseminated. Lister's chagrin can well be imagined, but in this short paper we can hardly afford the time to quote from his published letters on this subject. Very wisely he did not allow himself to be drawn deeply into the controversy, but continued his efforts toward the improvement of his technique, and in open lecture and published paper continually reiterated that his discovery was a fundamental principle and not a new method of dressing.

His successful treatment of cases continued. Visitors from other countries as well as from near by came to his wards for purposes of observation. Those who came and actually saw seem to have been well satisfied, and year by year his teaching was spread by his own students as they passed out to new fields of endeavor. He no longer used strong carbolic acid, but found a 5 per cent. solution adequate. Even at this time he was trying to dispense with antiseptics. He states:

Of all those who use antiseptics in surgery, I expect that I apply them least to the surface of the wound.

At this time also he was attempting to find a suitable "protective," a non-stimulating substance impervious to carbolic acid; varnished oiled silk was his final word in this direction.

Secondary hemorrhage was a continual source of danger in

the septic wounds of that day and Lister was the first to recognize why the ligatures sloughed away from such a wound. He did much experimental work in attempting to find a ligature which should be strong enough and yet capable of being digested finally by the fluids of the body. Silk ligatures soaked in strong carbolic for two hours, catgut ligatures soaked in a great variety of disinfecting solutions, were used one after another. His final process in 1908 was the use of chromium sulphate and corrosive sublimate as a means of disinfecting well-seasoned catgut. This and several other methods of treating catgut devised by Lister are still in use to-day.

In the spring of 1869 Syme had a paralytic stroke and in the summer he resigned his chair, urging Lister to become a candidate for it. A large number of the Edinburgh students sent a delightful letter to Lister urging his candidacy and on August 18 he received news of his election to the Edinburgh professorship. A month after this appointment Lister's father, almost eighty-four years old, was taken ill and shortly afterwards died. For Lister, this meant a deep personal loss and led to the breaking up of the old home at Upton.

EDINBURGH, 1869-1877

The Listers moved to Edinburgh in October, 1869. He settled at No. 9 Charlotte Square in one of the most fashionable parts of the city and had to pay what he called "a most enormous sum" for it. His private practise developed very rapidly, his lectures were largely attended by an enthusiastic group of students and he was delighted to find his expectations realized in that his life was not as tied up with routine as at Glasgow. His university duties were considerably less, inasmuch as he gave only two clinical lectures a week, instead of the daily lecture in systematic surgery. He also enjoyed the fact that his hospital visit occurred at noon in Edinburgh instead of the early morning as at Glasgow.

He found many changes in Edinburgh from the conditions that had prevailed ten years before. Syme and Simpson, the two strongest personalities, were both nearing the close of their active lives. Syme indeed died in June after Lister's return to Edinburgh. He mourned the loss of Syme very deeply. The relation between the two had been almost that of father and son. Lister had always trusted much in Syme's advice and in his judgment, but with the death of Syme, Lister stepped into the first place among the surgeons of Scotland.

Lister began again to devote more of his time to investigations and bedtime was frequently postponed until four or five o'clock in the morning, while he made careful notes or delicate camera lucida drawings. His hospital visits occurring at noon caused the noon-day meal to be decidedly a movable feast. Each antiseptic case received his personal attention, and the assistants frequently became very hungry while their "chief" attended to details which seemed to them very minute. The classes were large, sometimes numbering 170 to 180, and the lectures, judging from the reports of his students, were intensely interesting. He no longer spent hours in preparation for his lectures, but perhaps half an hour sitting quietly in his armchair, thinking.

His laboratory work for the next few years was largely bacteriological in character. Four or five hundred closely written foolscap pages with many careful drawings in what he called his "common-place" book give evidence as to the large amount of time spent in bacteriological work. Altogether he published six papers dealing with bacteriological subjects, no one of which gives evidence of observations of lasting importance. They did, however, bring him into touch with Louis Pasteur and the correspondence between the two is delightfully interesting.

Two modifications of his surgical technique were introduced during the early years of his second Edinburgh period. The first was the carbolic acid spray, about which so much has been said in open ridicule and the second the use of absorbent gauze dressings. Pasteur's teachings, it must be admitted, strongly favored the air-borne theory, and there was at that time no clear-cut distinction between pathogenic and saprophytic organisms. In the use of the carbolic spray, Lister allowed his theorizing to lead him away from his experimental basis. In this period of his work it seems to me that he rather neglected his earlier fundamental conceptions, becoming infatuated with carbolic acid as a panacea. So in the minds of many the term "carbolic acid treatment" was superseded by the "spray and gauze treatment." Lister's notion was that the spray would mechanically cleanse the air and destroy the bacteria present. The machine for the production of the spray passed through a regular evolution from a small hand atomizer, to a foot spray worked with a bellows, to a cumbersome tripod machine worked with a long handle which bore the name of "the donkey engine" among the scoffers and finally to a beautifully designed machine producing a steam spray. The spray

was used in many parts of the world for years, although doubts arose in the minds of many and finally Bruns of Tübingen (1880) condemned it in a forceful paper entitled "Fort mit dem Spray." Lister finally abandoned the spray in 1887, acknowledged that its use had been based on a misconception of the facts, that pathogenic organisms were not very plentiful in the air, that it was extremely irritating to the hands of the operators, and that the air was not, after all, the principal source of wound infection. At the International Medical Congress at Berlin in 1890, he states:

As regards the spray, I feel ashamed that I should ever have recommended it for the purpose of destroying microbes in the air.

The substitution of the gauze dressing for the plaster was a distinct improvement in Lister's mind, because it made the antiseptic treatment easier to carry out. Many different antiseptics were used to saturate the gauze and a great deal of experimentation was carried out to test each one. Oakum dressings, carbolic gauze, gauze soaked in corrosive sublimate, the double cyanide of zinc and mercury, all the different common salts of mercury, many volatile disinfectants, sero-sublimate gauze, and boric acid all passed through various stages of trial in his laboratory and wards. Several papers in this field were published in the *British Medical Journal* and the *Lancet* in the years from 1884 to the end of his active life as a surgeon.

The story of the gradual spread of Lister's teachings need hardly be recorded save in the briefest form. The controversy was waged and there were those who scoffed, but for the most part the junior physicians and surgeons everywhere were beginning to swing towards Lister's point of view. Among those on the continent who became his adherents must be mentioned Ernst von Bergmann, who became convinced that the antiseptic method was only a stage in the development of surgical technique and that the aseptic method must be the treatment of the future. He became the apostle of aseptic surgery and was instrumental in the general hospital improvement that dated from this period. Lister's teachings were accepted more rapidly in Germany, Switzerland and Scandinavia, than in England. Of the foreign countries France was especially slow to take up the modern methods.

During these years at Edinburgh his published papers were numerous. No less than ten connected with antiseptics and two on fermentation appeared between 1870 and 1876. During the Franco-Prussian War his hope that antiseptic methods

would lead to more adequate control of infected wounds was only partly realized.

In 1875 he made an extended continental tour with his wife and other members of his family. The first part of the trip, spent for the most part in Italy, was largely for pleasure, whereas the latter part, through the university towns of Germany, was a triumphal procession. He was dined and wined by physicians and students who welcomed him as the forerunner of modern surgery.

They returned to Edinburgh toward the end of June and immediately afterwards he took the first of many trips in opposition to the work of the anti-vivisectionists. This group of misguided sentimentalists became extremely active in England and, in spite of the opposition of Lister and other leaders in medicine and the biological sciences, put through a "cruelty to animals act" in Parliament which has hampered the efforts of experimenters in that country even to this day. Lister's letter to the Queen opposing the "cruelty to animals act" is a model of courteous but strong opposition to the restriction of well-handled animal experimentation. The law as passed forbids any experimentation save in a registered house by licensed investigators.

It forbids the granting of a special license to a distinguished doctor to experiment on a chloroformed frog in his own study in pursuit of science, while it allows any one who can afford it to hunt a stag to death or set two greyhounds to chase a hare and wager money on the result.

In September, 1876, Lister, together with Mrs. Lister and his brother, attended the International Medical Congress at Philadelphia. Lister was made president of the Surgical Section, taking a prominent part in many of the debates. He traveled extensively both before and after the congress, visiting Montreal, Toronto, Niagara, going as far west as San Francisco.

In 1877 a chair of clinical surgery was created for Lister at King's College, London, and in spite of the vehement opposition of his students, Lister accepted it.

It is perhaps difficult to understand why Lister should have wanted to leave his preeminent position in Edinburgh, with his well-trained assistants in a hospital dominated by him, where he had large classes of enthusiastic and affectionate students and friends of long standing. But he left these desirable conditions to accept the position at King's College with a comparatively small London hospital, where the average class was less than 25 and where apathy or distinct opposition must be met daily. His primary reason for making the change was that

London was the only city of any prominence that had not adopted his procedures. He felt that he must carry the gospel to the Romans. He was a man with a mission.

LONDON, 1877-1893

In London the Listers lived at No. 12 Park Crescent, well away from the fashionable quarter and also remote from the recognized consultant's quarter, but near the Park Square Gardens and also the Botanical Gardens, and that was what Lister desired. He did not build up a large private practise in London. This was partly due to his lack of punctuality, and partly to his preference learned from Syme of leaving the amount of his fee to the patient's decision. This always placed the consulting physician in rather an embarrassing situation. He also did not wish to leave the after care of his patients to the physician consulting him, who usually had no notion as to Lister's methods. But he had just about the amount of practise he desired; patients were sent to him from all parts of the British Isles. He enjoyed immensely the personal relation established in private practise, taking the keenest interest in the affairs of his patients, and they in turn regarded him with veneration. He would have vigorously opposed our full-time clinical professorships just as at that day he opposed the notion that the professor of pathology should not have beds in the hospital.

He brought with him from Edinburgh four men to form the basis of his staff in King's Hospital. Without the assistance of these well-trained men he would have found it extremely difficult to do anything in the uncongenial atmosphere of King's College Hospital. With the nursing department, there was continued friction. The Sisterhoods were bound by their own notions and inflexible rules. His assistants, Watson Cheyne and John Stewart, tell of several amusing and almost tragic instances of the absurd obstinacy of the Sisters in charge.

One feature of Lister's methods of treatment is worthy of note in that it brings out Lister's great personal interest in his cases as well as the difficulties with the nursing organization. Chronic cases of tuberculosis of the bone, psoas abscesses, etc., which formerly were almost always fatal, became curable, but only with prolonged and careful treatment, so that some cases remained in the hospital for a long period of time. In October, 1877, the managers of the Edinburgh Royal Infirmary decided to discharge some of these chronic cases which Lister had left behind. One woman, Lizzie Thomas, came to London, as Lister.

wished her admitted to King's College Hospital. She was brought by the Scotch head nurse in a basket such as were used to move patients in the Edinburgh hospitals. In spite of the fact that it was a cold bleak October morning, the basket and its contents were placed on the floor, while the Sisters insisted that the patient could not be admitted till the secretary arrived two hours later to draw up the regular papers for admittance. Not till Lister's assistant, John Stewart, threatened to put Lizzie to bed himself, with the assistance of the Crimean veteran porter, did the shocked Sisters reluctantly consent to take charge of the patient before all the usual formalities had been observed. In spite of her ungracious reception the patient recovered, as did the other six chronic cases whom Lister sent, at his own expense, to a nursing home, after they had been summarily discharged by the Edinburgh Infirmary.

He attempted to introduce the ward methods of teaching surgery that he had used in Edinburgh, but there were very few cases and the students were apathetic. Lister's classes remained small. Coaching classes were the order of the day and the London examination system which Lister vehemently opposed gave no power to the professor in charge of the course. Students found that Lister's views were not acceptable to the examiners, so they avoided his clinics, and instead of the 400 eager students as at Edinburgh, his lectures were attended by a bare dozen.

Gradually, however, the successful cases made an impression even in London and his lectures began to attract a few general practitioners and a goodly attendance of foreigners.

During his London period, Lister gave many addresses and attended numerous medical congresses. He was a juror at the University Exhibition at Paris in 1878 and seized the opportunity to become more familiar with Pasteur and his work. At the sixth International Medical Congress in Amsterdam, a great reception was tendered him, the ovation at his entrance lasting for some minutes. The seventh International Medical Congress met in London in 1881 and was a memorable occasion. Virchow, Volkmann, Pasteur, Billings and Huxley gave general addresses. The most remarkable paper at the meeting was given by Pasteur on "Vaccination in Relation to Chicken Cholera and Splenic Fever."

For fifteen years Lister occupied the chair of clinical surgery at King's College. His private duties were numerous and his public life became more and more complex. He received honorary degrees and various orders of merit from different

ruling monarchs. In 1883 he was made Baronet. His life in London, however, was less strenuous than that in Edinburgh. Experimentation went on as before and the "Commonplace book" is full of experiments on catgut, gauze, and various germicides. London was finally won over by the pertinacity of Lister and the gradual piling up of facts. Even the *Lancet* published laudatory remarks. He played more and more a leading part in public affairs and in medical education. He always opposed the admission of women to medical schools.

All this time, Pasteur had continued his remarkable studies on the production of active immunity by the introduction of attenuated organisms until one after another the diseases of chicken cholera, anthrax and finally rabies were rendered, if not harmless, at least less dangerous to man and other animals. In order to aid the work in the preventive treatment of rabies the Institut Pasteur was founded and for a number of years it was necessary to send all persons in Great Britain who needed treatment for this disease to Paris. Feeling that this condition should be rectified, Lister and others of the medical profession attempted to establish a similar institute in Great Britain. In spite of much opposition on the part of the anti-vivisectionists the British Institute for Preventive Medicine was established on June 5, 1891. This Institute, finally renamed after Lister, has gone through many vicissitudes but is still fulfilling the purpose of its founders.

As Lister's duties became less burdensome owing to advancing years, his vacations became more numerous and longer, although he never neglected this part of a normal life. He traveled widely, frequently making some medical congress the excuse for the trip. He visited Norway after the Amsterdam congress in 1880, visited Spain repeatedly, had an interesting trip through the Dolomites in 1881 and attended the International Medical Congress in Berlin in 1890. During all his vacations he spent much of his time in the open; he was devoted to fishing and was always interested in field botany. Many of his botanical trips were made with his brother Arthur, who later became an authority on the Myxomycetes. During the latter half of his life, Lister became an ardent follower of Audubon, and could frequently be seen, when on his vacations, with a vasculum over one shoulder and a bird glass over the other.

One of the most dramatic occasions of this period of his life was the Pasteur Jubilee celebrated at the Sorbonne on December 27, 1892. After the opening speeches by the president of the republic and the dean of the section, Lister was called upon

as the representative of the Royal Society of London and the Royal Society of Edinburgh. His address is a delightfully enthusiastic appreciation of the work of the great Frenchman. At the close of the speech,

Monsieur Pasteur se lève pour embrasser M. Lister. L'étreinte de ces deux hommes était comme la représentation vivante de la fraternité de la science dans le soulagement de l'humanité.

During the usual spring holiday in the next year, 1893, Lord and Lady Lister (for he had now been made a peer of the realm) went to the Italian Riviera. After about a week of botanizing, Lady Lister suddenly developed an acute pneumonia which resulted fatally.

Lister was now a solitary man. They had had no children and he and his wife had been intimate sharers of their mutual joys and sorrows for thirty-seven years. She had always entered keenly into his scientific work and the numerous "commonplace books" in which are recorded his many experimental observations are largely in her handwriting.

The year before his wife's death Lister had been retired at the age of sixty-five from the professorship at King's College, but his duties at the hospital continued through 1893. At the end of that session he ceased his work in the wards and also terminated most of his private practise. He was still mentally and physically vigorous but the death of his wife and the cessation of his regular duties depressed him very greatly.

DECLINING YEARS, 1893-1912

With the death of his wife social gatherings at Park Crescent came largely to an end and he seemed to have no zest even for his experimental work. To give him some regular occupation his friends obtained for him the foreign secretaryship of the Royal Society in November, 1893. He held this position until 1895, when he was elected president. His life for the next four or five years consisted of his duties in this society, officiating at many public ceremonies, and serving in the upper house of Parliament. A number of interesting general addresses date from this period of his life.

In the autumn of 1897 Lister again visited America on the occasion of the annual meetings of the British Association for the Advancement of Science at Toronto and the British Medical Association at Montreal. Following the public ceremonies, Lister and his companions made a tour of the west, taking in Vancouver, Seattle and Yellowstone Park.

At the second Tuberculosis Congress in 1901, Lister presided on the occasion of Koch's paper relative to the non-infectiousness of the bovine tubercle bacillus for human beings. Lister's impromptu criticism of this paper showed a remarkable grasp of the subject and gave proof of the fact that his mind was still keen in analysis in that he pointed out several of the weak points in Koch's argument.

On the occasion of his eightieth birthday, his professional friends determined to gather all of his more important papers and addresses into a memorial volume. He was very much interested in this publication and took an active part in aiding the committee who had it in charge. The collected papers were finally published in June, 1919, in two quarto volumes with many reproductions of Lister's original drawings.

The last seven or eight years of Lister's life were tedious and certainly years of "labor and sorrow." In the latter part of 1909 his sight and hearing became much impaired and although he continued to dictate letters, he could neither read nor write. His sister-in-law, Miss Syme, was with him continually during the latter years of his life and ministered to his comfort. Pandora's gift was also still with him and to the very last he hoped to be able to finish an unpublished research on the nature and cause of suppuration. He died February 12, 1912. By his own wish he was not buried in Westminster Abbey, but at the West Hampstead Cemetery beside his wife.

It is not difficult at this period to evaluate the work of Joseph Lister. With all due credit to Semmelweiss and Lemaire, it was the driving force of Lister and his work that played a large part in the overthrow of the reign of "laudable pus" and the crowning of the far-reaching experiments of Pasteur with the effective methods of modern surgery. Aside from this, his greatest work, he will be remembered for his painstaking observations on the contractile tissues of the iris, and his overthrow of the then current theory that coagulation of the blood was due to the liberation of ammonia, showing instead that in the blood vessels at least it depended upon injury to the tissues. His paper on excision of the wrist for caries is a classic, and the introduction of the catgut suture in surgery of the vascular system, and absorbent gauze bandages in all open wounds were definite advance steps.

Lister in all his work was diligent and painstaking, not spectacular or brilliant. As an operator he was usually slow, punctilious in the arrest of hemorrhage and in the stitching of wounds. His hands were steady and skilful. He planned each

operation before beginning it, laying out his instruments as he mentally rehearsed the operation step by step. His voice was musical and in public he spoke deliberately and clearly. He had a slight stammer which was scarcely noticeable when he felt fresh and vigorous. From the first he was much respected by his students and as years passed this developed into an enthusiastic devotion. John Stewart writes in 1910, "The difficulty will be for any man to find language to express what our Master was to us. We knew we were in contact with a genius, we felt we were helping in the making of history and that all things were becoming new." Lister was almost worshiped by his patients. He was so extremely sympathetic, so gracious in his manner, and so attentive to all their wants. His thoughtful face showed obvious mastery of himself and of his situation.

The general feeling towards Lister both now and during the later years of his life is well expressed by a happy phrase of Sir Michael Foster's at the end of a speech delivered at Toronto,

In early life Lister belonged to a Society the members of which called all men Friends, and now in turn because of his inestimable beneficence and service to mankind, all men the world over call him Friend.

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